Vol. 4 No. 1

TORREYA

January, 1904

PHYSIOLOGICAL APPLIANCES — I

By George E. Stone

The appliances described in this series of notes have been improvised in the writer's laboratory during the past few years, in connection with a physiological practicum, and while they may not possess much value to the investigator, they have proved useful in the students' hands. We realize that physiologists have their own methods of demonstrating physiological phenomena. Now and then, however, there appear in various journals helpful suggestions in regard to demonstration methods which the writer has found interesting and profitable, and it is hoped those now to be offered may prove the same to others.

Appliances for determining the Amount of Carbon Dioxide taken up by Plants

As a means of determining that plants take in carbon dioxide under the influence of sunlight, the writer's students in physiology have for some years made use of the following apparatus with satisfactory results.

Fig. 1 shows an appliance designed largely for experiments with leaves. Briefly stated, it is a modification of the Winkler-Hempel apparatus for gas analysis. The apparatus consists of a bulb burette provided with a two-way stop-cock, and has an aperture at the bottom, closed with a rubber stopper, for the insertion of the specimens. The burette is graduated to $\frac{1}{10}$ c.c. and has a capacity of 85 c.c. The method of using the apparatus is quite similar to that of the Winkler-Hempel gas burette. The

[Vol. 3, No. 12, of Torreya, comprising pages 177–201, was issued December 22, 1903.]

only practical difference being that when specimens are placed in the bulb their volume has to be determined; in other words, the capacity of the burette has to be reëstimated. This is done by filling the burette and measuring the contents with another burette or pipette. The principal feature of the apparatus consists in having the specimens in the burette that is employed in making the determination. For experimental purposes we gener-

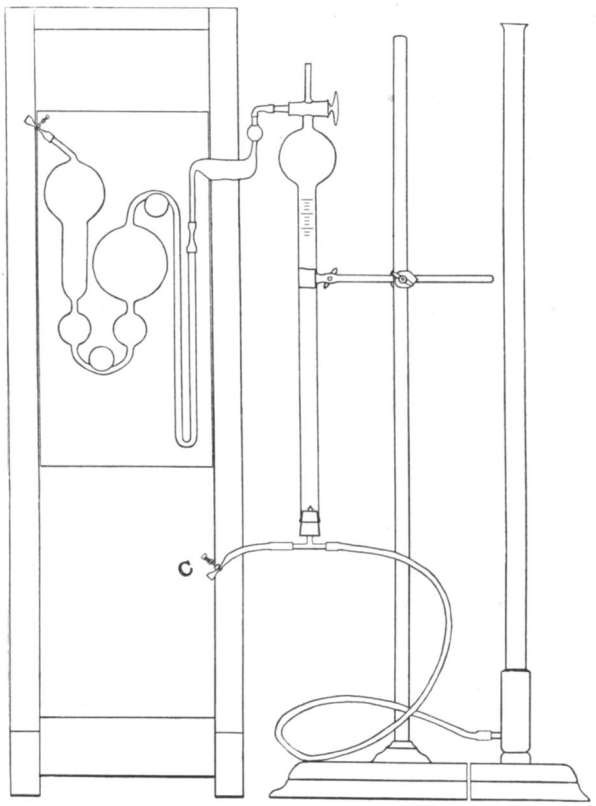

FIG. 1. Apparatus for determining the amount of carbon dioxide taken up by plant tissues.

ally select *Myriophyllum* leaves and have about 5 or 10 per cent. of carbon dioxide in the burette. The method of operation is as follows: The required amount of carbon dioxide is supplied to the burette containing the plants by first filling with water or mer-

cury, and allowing all but 5 or 10 per cent. of this to be replaced by air, and the remaining space by carbon dioxide. After exposing the plants to sunlight for a given length of time, the air in burette is forced over into the potash bulb, and after a short period returned. This is accomplished by the pressure of mercury or water, whichever happens to be used. The difference in volume is then noted and from this is calculated the percentage of carbon dioxide absorbed. Either water or mercury may be employed, and when the former is used we usually take the water from a reservoir suspended five or six feet above the apparatus, in which case we regulate the output of water by the stop-cock shown at *C* in Fig. 1. We seldom allow the contents of the burette to go below the 83 or 84 c.c. mark. In using water, a small portion of the carbon dioxide is likely to become absorbed. The absorption of carbon dioxide, however, can be largely prevented by a drop of oil on the surface of the water. In case mercury is used, no such precaution is necessary. It has been our practice to allow students to make a few analyses of the carbon dioxide, previous to placing the plants in the bulb, in order that they may become familiar with the method and test the accuracy of the same. We prefer very small apertures in the two-way stop-cock; this makes the apparatus much easier to work, and there is less opportunity for leakage. The special bulb burette is made by E. Greiner, of New York.

When it becomes necessary to make experiments with potted plants, we have used for some years the apparatus represented in Fig. 2. This consists of a bell glass set in a paraffined wooden trough filled with mercury. The potted plant to be experimented with is covered tightly with thin rubber sheeting, which permits only the leaves and upper portions of the stems to be exposed. There are two wide-mouthed tubes, one inside the bell glass, *h*, and one outside, *f*, which contain water. These are connected with a U-shaped tube below, with clamps at *a*, *b*, and *c*.

In supplying the apparatus with carbon dioxide, the generator is attached to one of the inlet tubes at the top of the bell glass, and the inner tube, *h*, which is completely filled with water, is

drawn off. This allows a certain amount of gas to enter, but the exact percentage contained in the bell glass must be determined by analysis. This is accomplished by passing a sample of the gas in the Winkler-Hempel burette, which necessitates allowing water to pass from *f* to *h* in order to counterbalance the air pressure. After exposure to light for a required length of time, other samples of air can be taken and analyzed as before. The

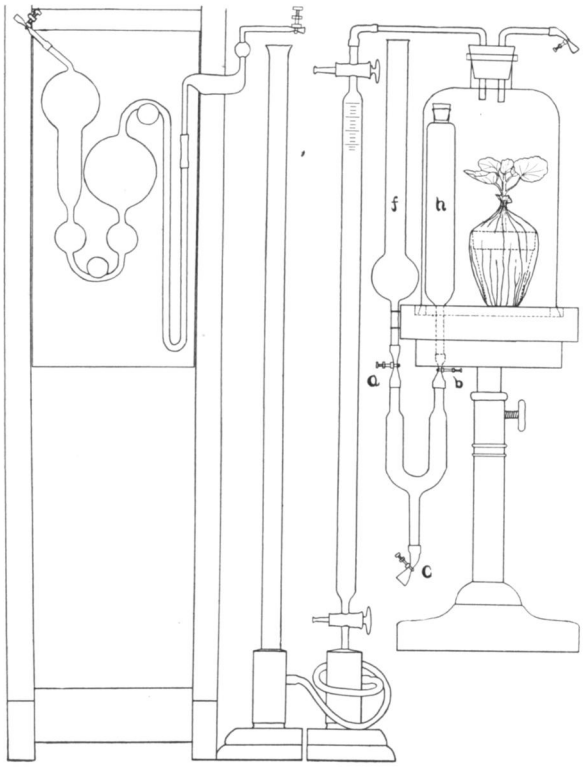

FIG. 2. Apparatus for determining the amount of carbon dioxide taken up by potted plants.

number of samples of air which can be taken depends entirely upon the capacity of the inner tube, *h*, and also the amount of gas, or air, which is utilized each time as a sample for analysis. We have found it better to supply the plants with a considerably large percentage of carbon dioxide, as this renders the results

more marked. The principal feature to bear in mind, in the use of this form of apparatus, is to regulate the inflow and outflow so that the pressure of the air under the bell glass coincides with that outside of it. The amount of carbon dioxide which plants absorb is sufficiently large so that with the use of either of these appliances a slight error in the determination does not prevent their being utilized for demonstration purposes. Such experiments may well precede those with the Pfeffer gas-balloon, in which case more careful details in regard to pressure and tension have to be insisted upon.

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OBSERVATIONS ON PHALLUS RAVENELII

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In the fall of 1900, several beds of *Phallus Ravenelii* were found in piles of sawdust at Williamsport, Pa., with the plants in all stages of development. "Eggs" were found in abundance from the size of a mustard seed to that of a walnut. In a space less than three feet square over a hundred and fifty were gathered, all larger than a pea while hundreds of smaller ones were to be found. The sawdust was penetrated in every direction by long strings of cord-like mycelium. Most of the smaller "eggs" failed to mature, being checked by the frost, but the plants persisted in coming up until the middle of December or until the ground actually froze hard.

One of the beds was located under a pile of lumber, where it was more shaded and more moist. The *Phalli* in this bed were larger and of more vigorous growth than those in the open. Tempted by their size, the writer made an effort to crawl under the lumber pile to them. The sawdust was found to be remarkably full of what was taken to be masses of "eggs" and unusually matted together by the mycelium, but it was too dark to see clearly of what the material consisted. A quantity was therefore gathered and on returning to the light proved to be very different from what was expected. There was a dense mass